the evening the members held an evening session for the reading of papers.

Exeter has been fixed upon as the place of meeting next year.

THE ELECTRIC TELEGRAPH—ITS IMPROVEMENT AND CAPABILITIES

In the beginning of the present year a Society of Telegraph Engineers was established for the general advancement of electrical and telegraphic science, intended to include not only those persons who are professionally connected with telegraphy, but those also who from their position and pursuits are enabled to render assistance in telegraphic enterprise. The institution has made a successful and promising commencement, the members at the opening meeting in February last numbering 110, the list including the historical names of Wheatstone and Cooke, the distinguished names of Thompson, Tyndall, and others scarcely less renowned for their important contributions to electrical science. The President, Mr. C. W. Siemens, D.C.L., in the course of his inaugural address, said:—

History teaches us how to read the events of the present day, and what we may reasonably look forward to even in the future; let us, therefore, review shortly in our minds the remarkable history of the Electric Telegraph, in order that we may be better prepared to deal with questions of immediate interest.

A generation has hardly passed away since the remarkable discoveries of Oersted, Ampêre, Faraday, and Weber, which laid the foundation of the electro-magnetic telegraph. The names of Steinheil, Schilling, Ronalds, Wheatstone, Cooke, and Morse furnish us with striking illustrations of the readiness with which the thinking men of different nations turn scientific discovery to practical use. While these pioneers in the field of telegraphic progress were still contending against practical difficulties, other earnest labourers entered the same field, amongst whom Werner Siemens, Bain, and Brequet should not pass unmentioned here. But so rapid has been the progress of our branch of science, that, while I am obliged to speak of these men as belonging to our early history, they are still, almost without exception, living amongst us in full enjoyment of their faculties, and, I am happy to add, members of our new society. They have the rare satisfaction to see their early day-dreams carried out upon so vast a scale that there is to-day hardly a country, however remote, that is not within a few minutes', or at all events a few hours' call, from every central point of the civilised world, that diplomatic conferences have to be held to regulate international telegraphy, and that a proposal is seriously entertained by the leading powers of the earth to place telegraphic property upon the highest, I may also say a sacred basis, by declaring it inviolable in case of war. The electric telegraph has, indeed, attained to the dignity of a commercial, a social, and an international institution of the highest importance; it is a civiliser of the first magnitude, and we may well be proud to meet here together in furtherance of such a cause.

You will pardon me if I abstain from making special reference to the numerous claims to recognition of the fellow-labourers of the present day whom I am now addressing; they are well known within our own circle and to the public at large, but neither my ability nor the time at my command would suffice for such a task. I will only endeavour, before concluding this address, to summarise the subject-matters which, judging from my experience, should engage our principal attention.

Problems of pure electrical science meet the telegraph engineer at every turn, the methods of testing insulated wire, of determining the position of a fault in a submarine cable under various circumstances, or of combining instruments so as to produce recorded messages by the mere fluctuation of electrical tension in a long submarine conductor, are problems worthy of the most profound physicist and mathematician. On the other hand, there is hardly a problem in electrical science that is not of practical interest to the Telegraph Engineer; and, considering that electricity is not represented at present by a separate learned society, ranking with the Chemical or Astronomical Societies, I am of opinion that we should not exclude from our subjects questions of purely electrical science. The phenomena of electrification and polarisation, of specific induction and conduction, the laws regulating the electrical wave, the influences of rise of temperature on conduction or the potential force residing in a coil of wire of a given form, when traversed by a current, involves questions belonging just as much to pure physical science as to the daily practice of the Telegraph Engineer, and would at any rate be inseparable from our proceedings. Next in order come questions of selection of materials for conduction or insulation, of apparatus for the best utilisation of feeble currents, of apparatus for producing, alternating, and directing electrical currents, which, although still intimately connected with physical science, call into play considerations of mechanical combinations. This brings us to questions of purely mechanical import, such as the mechanical construction of instruments for recording or printing messages, of protecting and supporting insulated conductors by sea or land, or of constructing machinery for the manufacture, the laying, and the repairing of submarine cables.

These questions again lead up to the more general ones of transport of materials through difficult and inhospitable countries, of navigation, of investigations into the depth and the nature of the bottom of the seas, into the nature and effect of sea currents, and so forth, all of which belong, under certain aspects at least, to the province of the Telegraph Engineer.

I would go further, and include even statistical information respecting the nature and growth of telegraphic correspondence, without which it is impossible to adapt the construction of lines and of working instruments to the acquirements of particular cases. The invention of a telegraphic instrument, for instance, is only of practical value if it is suited to the circumstances of the particular traffic for which it is intended, and to the electrical condition of the lines which it is proposed to work, and when the early pioneers of telegraphic progress elaborated ingenious instruments for sending and recording messages automatically or for printing them in Roman type, they invariably failed, because the then-existing lines were insufficient in every way for such refinement, and the simple needle instrument seemed to suffice for all practical purposes. It was only when the exigencies of the traffic demanded a change that instruments of this nature proved to be valuable inventions.

In like manner the long underground lines that were established on the Continent at an early date had to give way to suspended line-wire, whereas the present practice and necessities undoubtedly tend toward a reversion to the former, as being less liable to interruption by accident or by atmospheric influences, and because an unlimited number of underground wires may be established between any two stations without encumbering the public thoroughfares. The best mode of insulating and protecting these underground wires with a view to reducing the inductive influence of the one upon the other, and of facilitating access to the one, for the purpose of repairs, without disturbing the others, are questions of practical interest for the present day.

The Electric Telegraph is applicable with the greatest positive advantage for the intercommunication between two points a great distance apart; through its agency New York and Calcutta are as near to us in point of time as are the suburbs of our metropolis from one another.

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It is probable, indeed, that in telegraphing from one suburb to another the message has to be oftener retransmitted than in going from the City of London to India or America, because a direct transmission from any one part of London to another would involve almost an infinite number of line-wires in all directions. For this reason there must be a limit to the applicability of the Electric Telegraphs in populous districts, and it behoves us to examine whether another agent may not be preferable in dealing with a traffic of this description. The pneumatic tube seems to be well adapted to these circumstances, and having been first applied for short distances by Latimer Clark, and subsequently modified and extended by others, it will fall within the province of our society to examine fully into this and kindred methods that may be devised for effecting rapid interchange of intelligence in towns.

THE BRITISH COAL-FIELDS

ONE distinguished geologist, at least, disbelieves in the speedy exhaustion of our coal-measures, so frequently predicted of late. At the annual meeting of the Dudley and Midland Geological and Scientific Society, Prof. Ramsay delivered an address on the existence of coal beneath the New Red and Permian strata, in the course of which he observed that for fifteen years he had been preparing to attack this subject, but it was not until he became a member of the Royal Coal Commission he had given it a really searching consideration. There could be no doubt that the various coal-fields of the Northern and Midland districts once formed one great coal-field, but had been separated by extensive denudation. Another great coal-field was formed by the now distinct fields of Devonshire, South Wales, Somersetshire, and the Forest of Dean. Between these two great divisions, the north and the south, there was no connection formed by the coal-measures, the poorer measures possibly having been deposited there, but not the rich deep ones in the carboniferous era. Referring more especially to the Midland district, he thought it highly probable that coal-measures would be found to exist between the present boundary of the South Staffordshire district and the Forest of Wyre; but it was questionable whether it would be of a workable depth. On the west side of the South Staffordshire boundary, in the direction of Bridgenorth, Shropshire, he also believed coal to exist beneath the Permian strata, at a depth of 1,500 feet, or possibly more in some places. At the north of the South Staffordshire boundary, a line drawn from Wyrley right across to the Shropshire district would, he believed, include some valuable coal-beds, a considerable part, but not all, of which would be at a workable depth. He entertained no doubt that the coal-measures were continuous between the South Staffordshire and Shropshire districts, which, although in some places disturbed by denudations, might, throughout the greater part of the area, be profitably worked. In the North Warwickshire coal-field were found, in the direction of the Staffordshire boundary, five beds of coal, which gradually amalgamated, until on nearing Coventry they formed only two measures. The shale and sandstone were split up in like manner. These features constituted most important evidence in support of the theory that the Warwickshire, Staffordshire, and Shropshire districts were united by continuous coal-measures, the peculiarities referred to in the coal, shale, and sandstone strata being identical in all three districts. In that theory Prof. Ramsay was a firm believer. From Warwickshire to the south end of the South Staffordshire boundary, there was, he believed, coal, but not profitable. Towards the northern end of the South Staffordshire boundary, however, a line drawn from Coventry would include rich and valuable coal-measures. Between Staffordshire and Leicestershire the measures were also, he believed, continuous. From Wales to the Forest of Wyre there was profitable ground; but from Wyre on to Charnwood Forest, and east of that, there were no coals of value. The speaker expressed opinions equally assuring as to the presence of coal under the area lying between the north of the South Staffordshire boundary and the mountain limestones of Derbyshire. In one part of that district—viz., north-west of Cannock Chase—Prof. Ramsay said he should not feel the slightest hesitation in recommending a search for coal; and his belief in the presence of coal at a workable depth in the neighbourhood of Uttoxeter was equally strong. Now, supposing that his calculations were only approximately correct, the result would be surprising. It would amount to this—the coal now reckoned as available in the South Staffordshire and Shropshire districts was, in round numbers, 3,201,000,000 tons. If his belief were a true one, this supply would be further augmented by 10,000,000,000 tons. In Warwickshire the proved coal-measures are estimated to yield 458,000,000 tons, and the measures he believed to exist in addition would be 2,494,000,000, or five times more than the present estimate. The Leicestershire field was calculated to possess 836,000,000 tons, and this would be supplemented to the extent of 1,790,000,000. What was the case in regard to these districts was, he believed, equally applicable to many other parts of Great Britain. The South Wales, Forest of Dean, Bristol and Somerset districts were exceptions to this rule, the coal there lying in basins caused by denudations, the surrounding measures being destroyed. In the Midland districts these small basins are not found, the whole forming one great basin. Lancashire, Derby, and the Yorkshire coal-fields were, however, subdivided by the process of denudation. Still, he had no hesitation in believing that the estuary of the Dee and the Mersey have lying between them beds of coal, although probably at too great a depth to be of practical value.

MR. TODHUNTER ON THE ARC OF THE MERIDIAN MEASURED IN LAPLAND

MR. TODHUNTER has forwarded us a reprint from the "Transactions of the Cambridge Philosophical Society," in which he discusses the observations made in connection with the measurement of the arc of the meridian in Lapland in the last century. He states that having recently had occasion to study the details of the two measurements of the arc, he has been surprised to find that the accounts of these operations, although written by very distinguished astronomers, contain numerous and serious errors. We must refer our readers to the memoir itself for a complete account of the various points raised, for it is too long for adequate notice in the space at our disposal. A curious point, however, is raised as to the effect of theory upon observation in a paragraph which we quote *in extenso* :—

"It would be a curious subject of speculation whether the theoretical opinions of persons engaged in geodetical surveys could have exercised any influence on their observations; I mean of course unconsciously, for it would be wrong to suspect any deliberate unfairness in any of the operations which I have examined. From a passage in the article 'Figure de la Terre,' by D'Alembert in the original *Encyclopédie*, it would appear that the school of Cassini originally believed that in consequence of the oblate form of the earth, the length of a degree of the meridian *would decrease* from the equator to the pole. It seems strange, perhaps, now to suppose that such an error could be seriously maintained; but there can be no doubt of it; for example, the error was vehemently maintained by Keill, a man of some reputation, who was ultimately a

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